

U.S. Department of Transportation
Federal Aviation Administration

Subject: INFORMATION: Compliance Questions and
Answers with Respect to SFAR No. 88, Fuel Tank
Safety, for Transport Category Airplanes

Date: April 30, 2002

From: Manager, Transport Standards Staff, ANM-110

Reply to Mark Quam
Attn. of: ANM-113-02-013

To: See Distribution

This memorandum includes a compilation of questions and answers raised with respect to compliance with Special Federal Aviation Regulation (SFAR) 88, "Transport Airplane Fuel Tank System Design Review, Flammability Reduction, Maintenance and Inspection Requirements". The upcoming December, 2002, deadline for compliance with provisions of SFAR 88 has underscored a need to share additional guidance information in an expedited manner. This memorandum format was used to allow rapid dissemination of answers to the questions that have arisen and which need further clarification. This memorandum may be periodically revised in the future to include additional material as it becomes available.

Please contact Mike Dostert at (425) 227-2132, (email mike.dostert@faa.gov), or Mike Collins at (425) 227-2689, (email michael.collins@faa.gov) concerning questions regarding the guidance in this memo.

Michael J. Kaszycki

[Attachment](#)

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**Aircraft Certification Products and Services
SFAR 88 - Fuel Tank System Design Review,
Flammability Reduction, Maintenance and Inspection Requirements**

Transport Airplane Directorate	Regulations SFAR No. 88 Amdt 21-78	Advisory Circulars AC 25.981-1B AC 25.981-2	Policy Memo Questions & Answers	Additional Info Contacts Workshop
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Questions Raised With Respect to SFAR No. 88 (Q&A)

1. (6/28/2001) Do holders of STCs, which install APUs that tap into the Acft. fuel system need to do the analysis required by the SFAR?

Yes. If the change does not cause any affect on the fuel tank, or add components, wiring, etc. adjacent to the fuel tank (possibly causing an external ignition source) then a simple paragraph stating this would be all that is needed. If that change adds components such as valves, wiring, pumps adjacent to the fuel tanks then a more detailed assessment would be needed.

2. (7/16/2001) Advisory material is required to define the maximum resistance and impedance for each bonding provision and clear wording is needed on the need for and type of protection against lightning currents for bonding provisions in fuel tanks. Neither AC 25.981-A nor ACJ 25X899 provide clarification in this respect. Can you provide us with such information/advisory material? (Background: Some manufacturers have run simulated lightning tests on full scale fuel tanks and have promised sharing of test results but so far this did not materialize. Some TC holders do not have the capability to do such tests and can therefore not define the currents running through internal pipes and other components in fuel tanks from test results.)

There is no specific FAA guidance on maximum resistance or impedance of airplane electrical bonding provisions. Electrical bonding within a fuel system must be tailored to the performance requirements of a particular airplane design. The electrical bonding must consider the electrical sources, such as electrical faults, fuel static electrification, and lightning. The electrical bonding must also consider the specific airplane fuel system design, which would include the structure material used (aluminum, carbon fiber composites, fiberglass composites, etc.), the configuration of the fuel system (routing of fuel tubes, wires, and hydraulic tubes), and the electrical bonding concept (intentional isolation, self-bonding fittings, separate bonding jumpers, etc.) Given the large variation in design approaches, and the close relationship between the design approach and the electrical bonding requirements, it is not practical for FAA to provide specific guidance on maximum bonding resistance or impedance.

Airplane TC holders have performed tests on their airplanes to determine the specific requirements for electrical bonding for threats such as lightning. Other TC holders, in the absence of specific airplane test data, have chosen conservative electrical bonding approaches. Again, the approach is a decision each TC holder must make based on the specific situation for their airplane models.

3. (7/16/2001) "Major components" (§ 25.901(b)(4)) need to be clarified. Can you provide us with this clarification or a definition of "major components"? (Background: Some Wigg-o-flex couplings and Tee-pieces, which have no bonding provisions, have historically been used in fuel tanks based on very low or no static charge build-up and were not considered major components.)

There is no specific FAA guidance on "major components" in § 25.901(b)(4). However, the term "major components" in § 25.901(b)(4) should not be used to limit the review of fuel system ignition sources as required in FAR 25.981. Section 25.981 Fuel tank ignition prevention states: "(a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapors." This is in addition to the major components in § 25.901(b)(4). Fuel tube flexible coupling electrical bonding must be considered if these couplings are identified as ignition sources during the ignition source evaluation and assessment.

4. (7/16/2001) What is the FAA position on the effects of failure of a single bonding cable or other bonding provision as well as on the possible need for redundancy?

Section 25.981 Fuel tank ignition prevention states: "(a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapors. This must be shown by: ... (3) Demonstrating that an ignition source could not result from each single failure, from each single failure in combination with each latent failure condition not shown to be extremely remote, and from all combinations of failures not shown to be extremely improbable. The effects of manufacturing variability, aging, wear, corrosion, and likely damage must be considered."

Failure of bonding jumpers is generally considered a latent failure, since there is no annunciation or indication of the bonding failure. The airplane fleet fuel tank inspections that occurred as a result of the TWA 800 investigation showed that failure of bonding jumpers due to damage, wear, or manufacturing errors was not unusual. Based on this, it would be difficult to show that failure of a single bonding jumper is extremely remote or extremely improbable. Therefore, the electrical bonding jumper or other bonding provisions must consider the consequences of these latent failures. This may result in design changes that incorporate electrical bonding redundancy, if the failure of a single electrical bonding feature could create a fuel ignition source.

5. (7/16/2001) The need for and method of inspection of bonding provisions must be clarified. Can you provide us with this clarification? (Background: During bonding resistance measurements, damage of protective finish of components is caused in order to penetrate the insulating anodized surface layer, which is likely to lead to subsequent corrosion damage.)

The concern with damage to corrosion protection coatings is valid. This concern has resulted in some TC holders defining non-intrusive inspections for electrical bonding. These inspections may include detailed visual inspections, if the quality of the electrical bonding feature can be adequately assessed by visual cues, such as visible corrosion, breakage or missing bonding provisions. For the fuel tank SFAR detailed visual inspection would not by itself be adequate. Other inspections include inductively-coupled loop resistance measurements, to eliminate the need to disconnect bonding jumpers or to penetrate corrosion-prevention coatings. In any case, the need for and the method of inspection must be defined based on the specific situation for the TC holder's airplanes. The need for and the method of inspection should be a result of the assessments and evaluations carried out to determine the specific electrical bonding requirements referred to in Question 4.

6. (7/16/2001) Jet fuel ignition test results One of the possible fuel tank ignition sources listed in AC 25.981-1B is a heated filament. It specifically states that; "Analysis and testing indicate a small piece of wire from steel wool can ignite jet fuel when a current of 30 to 40 milliamperes root-mean-

square (RMS) is applied to the wire". The commenter has been unable to trace the origin of these test results, it is not mentioned in any of the official standards on intrinsic safety, nor could it be found in a large number of reports that deal with flammability and/or the ignition properties of jet fuel. Can the FAA indicate which document provided the basis for this limitation?

Based upon comments from several applicants during the SFAR compliance process the FAA has revised the information in AC 25.981-1B. We are in the process of issuing a revised AC that will be placed on the internet for easy access. The text below is the latest draft text and is provided as an advanced version for your use (2/12/2002). With regard to the filament heating energy limit, the data used in development of the AC was from proprietary testing submitted by several applicants and therefore is not publicly available. The FAA has initiated testing through the FAA Technical Center that will develop publicly releasable information. Applicants may conduct testing to substantiate alternate values.

a. Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks).

(1) Electrical sparks or voltage sparks can occur between conductive elements that are isolated from each other, due to voltage differences between the conductive elements arising from electrical system malfunctions, lightning, electrical faults or other electrical conditions. Electrical arcs or thermal sparks can occur when conductive elements, in contact with each other, eject molten or burning material when the current across the contact points exceeds the current-carrying capability of the contact points. (See references in paragraphs 4f (8), (9), and (12) of this AC.)

(2) Laboratory testing has shown that the minimum ignition energy required to ignite hydrocarbon fuel vapor is 200 microjoules.¹ Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the energy introduced into any fuel tank should be less than 200 microjoules during either normal operation or operation with failures (note that some components have been qualified to standards that allow 320 microjoules and this level is not acceptable for showing intrinsic safety). To ensure that the design has adequate reliability and acceptable maintenance intervals, a factor of safety should be applied to this value when establishing a design limit. For example, a maximum energy of 20 microjoules is considered an intrinsically safe design limit for fuel quantity indicating systems.

(3) Electrical transients caused by environmental conditions, such as lightning strikes, with the potential to create electrical sparks and arcs in the fuel tank should be limited so that the energy from any electrical spark or arc from the electrical transient is less than 200 microjoules. Optical detection methods and combustible vapor ignition detection methods used to show compliance for electrical transients caused by environmental conditions should detect sparks with energy levels of 200 microjoules or less. Optical detection methods consist of subjecting a fuel tank to a simulated lightning strike while a specific camera/lens/film configuration is positioned near the fuel system component, system or fuel tank with the shutter open. The test is passed if no spark is visible on the developed film. Combustible vapor ignition detection methods use specific combustible gas mixtures that have high ignition probability at a specific electrical energy. Fuel system components, systems, or fuel tanks are tested in the presence of the combustible vapor. The test passes if the vapor does not ignite during the test, but does ignite using a standardized ignition energy source at the specified ignition energy.

¹ The 200 microjoule level comes from various sources, the most quoted is Lewis and VonElbe, "Combustion, Flames and Explosions of Gases", that has a set of curves for minimum ignition energy for the various hydrocarbon compounds in Jet fuel, and they all have similar minimum

ignition energy levels of around 220 microjoules. The 20-microjoule limit is a safety factor on the 200-microjoule level.

c. Filament Heating Current Limit. Analyses and testing indicate a small piece of steel wool will ignite jet fuel when a current of approximately 60 milliamperes root-mean-square (RMS) is applied to the steel wool.² Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the electrical current introduced into any fuel tank should be limited. Because there is considerable uncertainty associated with the level of current necessary to produce an ignition source from filament heating, a factor of safety should be applied to this value when establishing a design limit. A maximum of steady-state current of 10 milliamperes RMS is considered an intrinsically safe design limit for fuel quantity indicating systems. Current levels above 10 milliamperes RMS, particularly for failures and transient conditions, could also be considered acceptable, provided that proper substantiation by test and/or analysis justifies them as intrinsically safe. For example, for transient conditions, it is acceptable to limit the energy in the transient to 50 microjoules, and failures that result in steady-state currents above 10 milliamperes RMS should be improbable and not result in currents greater than 30 milliamperes RMS.

² This data was from proprietary testing and therefore is not publicly available. The FAA has initiated testing through the FAA Technical Center that will be publicly releasable. Applicants may conduct testing to substantiate alternate values.

7. (8/02/2001) Should the STC holder work directly with TC ACO?

The STC holder should work with the cognizant STC ACO per the provisions of the SFAR. The STC ACO will be reviewing the reports and making determinations based on the guidance from the Transport Airplane Directorate. We have established a team of specialists to work with the ACOs to ensure standardization of the requirements and determinations of compliance.

8. What is your view on the need to review these fuel system issues with the PMA-holders (who do not have an STC)?

Follow-up: The commenter focused on those PMAs that are issued without prior STC (identically or reverse engineering). For those parts, the approval holder could make design changes, with no coordination without involving the TC holder. Perhaps it's not a big concern, but is an area not addressed by the FAR.

SFAR 88 applies to TCs and STCs, not PMAs. Any PMA issue associated with TC/STC holders, who have PMAs, will be inherently addressed in their system safety assessment. Similarly any PMAs that are identical to the TC/STC holders PMAs will automatically be addressed. Part numbers or identification could be an issue if ADs are written to modify or change an affected part. Non identical PMAs should be addressed in the operator system safety review.

9. (8/06/2001 & 8/10/2001) Does SFAR 88 apply to the AWACs, 747s, E4s

Use criteria in SFAR 88 to determine applicability.

10. (8/07/2001) With respect to intent of approving maintenance instructions, is the ACO engineer the one who will actually approve the maintenance recommended or was it the intent for the

engineer in conjunction with the Directorate AEG to conjointly approve the applicants recommended maintenance?

Here are the specific words from one of the SFAR related rules: "These instructions must address the actual configuration of the fuel tank systems of each affected airplane and must be approved by the FAA Aircraft Certification Office (ACO), or office of the Transport Airplane Directorate, having cognizance over the type certificate for the affected airplane." The reason for this requirement was in consideration of the complexity of the system safety assessment. The expertise of the AFS field offices and the AEG will be utilized in the final determination of the required maintenance and inspection tasks. Similarly, any escalation of required maintenance and inspection tasks would be through the approval of the cognizant ACO with assistance from appropriate Flight Standards personnel.

11. (8/2001) Fuel Pump Inlets - Do design holders need to assume sparks in the fuel pump inlets - regardless of the fuel pump design (or whether safety wire is allowed in the pumps, Al rotors on Al housings, etc.)?

Friction Sparks. The failure modes and effects analysis (FMEA) should include evaluation of the effects of debris entering the fuel pumps, including any debris that could be generated internally, such as any components upstream of the pump inlet. Industry fuel tank cleanliness practices and design features intended to preclude debris entering the fuel pumps have not been effective at eliminating debris. Service experience has shown that pump inlet check valves, inducers, nuts, bolts, rivets, fasteners, sealant, lockwire, etc. have been inducted into fuel pumps and contacted the impeller. This condition could result in creation of friction sparks and should be an assumed failure condition when conducting the system safety assessment. Fail-safe features should be incorporated into the fuel pump design to address this condition. Examples of means that may be incorporated into the fuel pump design to address this concern include:

- Installation of inlet flame arrestors,
- Use of reticulated foam,
- Use/installation of jet fuel pumps without impellers to scavenge fuel, or Maintaining fuel over the pump inlet throughout the airplane flight attitude envelope.

12. Are we going to mandate flame arrestors in the inlet lines (for those pumps that are allowed to run dry)? If we do, do we know of any other method of containing the resultant ignition of vapor besides using an arrestor? Are the design holder's only options: (1) addition of flame arrestors, or (2) keeping the inlets covered with fuel?

Not specifically, the applicant can use other means. Some manufacturers use collector tanks, filled by ejector pumps to keep the inlet covered. Others shut off pumps in aux tanks before they uncover and scavenge fuel using ejector pumps. See text in preceding question.

13. Vent System flame arrestors - (a) Are we going to mandate vent system flame arrestors? Reading the NPRM (FR 19853, 3/22/98) for an AD that was written for the B-737 100 through 500 series (resulting from the Philippines Airlines accident on may 11, 1990), it states:

One possible scenario which may have caused the 1990 accident is an external ignition of the fuel vapor exiting the fuel vent system and consequent propagation of a flame front into the wingtip

vent scoop and through the vent system into the center tank. The Model 737-300 vent system does not include flame arrestors and pressure relief valves and would allow a flame front to travel unimpeded into the vent system through the wingtip vent scoop. The conditions described above, if not corrected, could result in a potential source of ignition in a fuel tank.

It would appear that we are now considering external ignition sources outside the vent system.

(b) Does this need to be considered in the safety analysis of the SFAR 88 activities?

(a) No, the vent system flame arrestor rulemaking is currently tasked to ARAC and will be handled as separate rulemaking for post crash fire related concerns.

(b) External ignition sources that may result in explosion of the fuel tank must be addressed in the SFAR and it is possible that an ignition source such as a logo light might be identified as part of the safety assessment. In this case AD action may be taken..

14. Would it be possible for someone to get an STC for their transport category, turbine powered airplane that would limit its passenger capacity to say 29, and the maximum payload capacity to say, 7,499 lbs. - thus alleviating them from being subject to the SFAR 88 requirements?

Yes, though the STC, AFM, and "weight and balance manual" (and possibly the airplane by placard) should show the limitation. In addition, a note should be placed in these documents that states if 29 passengers or 7,499 lb. payload is exceeded, the airplane will have to comply with SFAR 88. The original TC holder would still need to do an assessment, while the new STC holder would not.

15. (8/14/2001) Will the airplane have to be on an experimental when obtaining temperature data for the auxiliary fuel tank?

The airplane can be tested under an experimental certificate or under a normal certificate if the test equipment is approved by STC.

16. (8/14/2001) Who approves the test plan for the temperature tests?

The cognizant ACO.

17. (8/14/2001) Many STC holders are a result of STC transfers. Most of the new holders have no information about prior operators who incorporated the STC. How are the operators found so that we can advise them of the SFAR?

FAA PMIs will be contacting their operators with respect to SFAR 88; so, if a STC holder does not know all the operators with their modifications, it is highly likely that the operators will be contacting the STC holders using the information from their airplane's records where the STCs that are installed should have been recorded.

18. Is there a definition of certificated payload?

The following are accepted definitions:

Payload (P/L): Total weight of maximum allowed passengers, cargo, and baggage (These may be revenue and (or) non-revenue.)

Maximum payload: Maximum design zero fuel weight minus operational empty weight.

Maximum design zero fuel weight (MZFW): Maximum weight allowed before usable fuel and other specified usable agents must be loaded in defined sections of the aircraft as limited by strength and airworthiness requirements. (Can be found in AFM)

Operational empty weight (OEW): Basic empty weight or fleet empty weight plus operational items (Can be found in Weight and Balance Manual or Operator's records)

Operational items: Personnel, equipment, and supplies necessary for a particular operation, but not included in basic empty weight (These items may vary for a particular aircraft and may include, but are not limited to, the following:

- (1) Crew and baggage
- (2) Manuals and navigational equipment
- (3) Removable service equipment for cabin, galley, and bar
- (4) Food and beverages, including liquor.
- (5) Usable fluids other than those in useful load
- (6) Life rafts, life vests, and emergency transmitters
- (7) Aircraft cargo handling system and cargo containers).

Note: To determine the applicability for airplanes that are delivered in the green (no interior), the certificate holder has the following options:

- 1) Assume no interior in determining payload, or
- 2) Assume a typical interior weight (based on the expected typical interior design) when determining the payload.

Also note the same model delivered in the cargo configuration may have to comply with SFAR 88 when that model with a business jet passenger interior may not have to comply or vice versa.

19. (9/18/2001) If a STC holder identifies an STC that is installed only on a foreign registered aircraft, what are their responsibilities?

The STC holder is still responsible for the type design change since this is a U.S approved type design. The STC holder is not responsible for the installation and continued airworthiness under U.S. regulations but should support the FCAA that has the responsibility.

20. (9/18/2001) Do foreign registered aircraft operating in the US under ICAO rules have to comply with SFAR88?

Foreign registered aircraft operating in the U.S under the ICAO rule are the responsibility of FCAA.

21. (9/18/2001) Foreign owned / operated, 'N' registered aircraft operating in the US under FAR 129.32 - do they need to comply with SFAR 88?

All 'N' registered aircraft must comply. The FAA can impose airworthiness requirements as the state of registry. The requirements of sections 129.14, 129.20, and 129.32 are based on our state of registry powers.

22. (9/18/2001) For AD written against a TC holder's aircraft, what are the STC holder's responsibilities?

The STC holder is responsible to evaluate how all ADs levied against TC holders' aircraft type design affect their STCs.

23. (9/18/2001) How will a STC holder determine compliance for STCs for which they don't have complete design definition and data?

This is the STC holder's responsibility; they may be required to conduct a design review for each installation for compliance and to update STC design data. It is the FAA's objective that the STC holder's compliance method with SFAR88 be consistent with the TC holder's, which holds the type design.

24. (9/18/2001) Can a STC holder surrender any or all of their STCs to the FAA?

Yes. However, the FAA cannot take responsibility for continued airworthiness on these STC installations and the operators assume full responsibility for the STC installations under SFAR 88. In addition, if an unsafe condition is found the FAA could issue an AD to modify or remove the installation, unless an operator can provide a specific program to show compliance to SFAR88.

25. (9/10/2001) Clarification of bonding strap requirement: A TC holder requested clarification of requirements for bonding straps and jumpers within the fuel tank.

The following statement at the SFAR Workshop: "Dual bonding straps for all components in the fuel tank or fuel vapor space are the only practical method of protection".

- Does this specifically stipulate the requirement of two bond straps for each component? From a practical standpoint the safety assessment would likely dictate a need for redundant bonding.
- Is the intent to demonstrate that each component has two means of dissipating electrical energy?

Yes. Is the intent to apply this requirement to both bonding "straps" and bonding "jumpers"? (i.e. Does "component" refer to only to powered components (such as pumps) or does it refer to items such as fuel lines.) Both. See question/answer 4.

Reference: FAA SFAR Workshop, Seattle Washington, June 20-21, 2001 - Fuel Tank Safety Assessment for Fuel Tank Safety, James J. Treacy.

26. (9/10/2001) Proposed compliance with FAR 25.981(a)(1) and (a)(2). A TC holder plans to use their original certification report as the basis of substantiation for FAR 25.981(a)(1) and (a)(2).

These regulations as stated in the SFAR reflect the same intent as the previously existing regulations FAR 25.981 (a) and (b). Reference: The Amendment, § 25.981 Fuel tank ignition proposal, p.23130. The adequacy of this report can only be judged based upon review of its content. Compliance documentation submitted by other manufacturers to show compliance to § 25.981 has not been adequate. However, the TC holder may have done a more thorough assessment but that would need to be evaluated on a case by case basis.

27. (9/10/2001) Subject: Applicability of FAR 25.901

A TC holder would like to clarify the intention of compliance requirement (a) of SFAR No. 88.

The TC holder is concerned that the SFAR regulation, as stated in requirement (a) below, captures all applicable requirements contained in subpart E. This would be a very large undertaking with end results, which do not reflect the intent of the SFAR.

The first sentence in part (a) of the SFAR compliance requirements states that...

"...each type certificate holder...must accomplish the following:

(a) Conduct a safety review of the airplane fuel tank system to determine that the design meets the requirements of §§ 25.901, ..."

For Subpart E - Powerplant, Section 25.901 Installation, Under section (b)(1), the regulation states that...

"The installation must comply with - ...

(ii) The applicable provisions of this subpart ;..."

At the FAA SFAR Workshop held in Seattle, WA June 20-21, 2001, Mike Dostert (FAA SFAR contact, Propulsion/Mechanical Systems Branch, ANM-112) stated that the intent of including the reference of FAR 25.901 in the SFAR requirements is solely focused on the "no single failure" requirement as stated in part (c) of FAR 25.901.

Reference: SFAR No. 88 - Fuel Tank System Fault Tolerance Evaluation Requirements, p. 23129.

Answer: The failure provisions of 25.901 (c) (including combinations of failures) are the portion of the rule that is intended to be addressed.

28. (9/10/2001) Item 9: FAA referenced documents in AC 25.981-1B A TC holder requests assistance in obtaining certain documents referenced in AC 25.981-1B.

See FAA Transport Airplane Directorate Designee Newsletter, Edition 15, February 1993. Article, Electrical Wiring used in Commercial Transport Airplanes. FAA Regulatory Support Division (AFS-500 or -600), Oklahoma City, Project 414-76a (01603), Explosion Potential for Electrical Items in Fuel Tanks. (This reference will be deleted from the next revision to the AC). FAA Document DOT/FAA/AR-98/26, Review of the Flammability Hazard of Jet A Fuel Vapor in Civil Transport Aircraft Fuel Tanks, June 1998. Copy available from FAA tech center web site, www.fire.tc.faa.gov

Reference: AC 25.981-1B, Section 4.f., page 3.

29. (9/10/2001) Amendment of AC 25.981-1B? Is an amendment to AC 25.981-1B planned for release as stated at the SFAR Workshop? When is it scheduled for release?

The FAA is working to develop a set of revisions to the AC. This work should be completed within the next 4 weeks such that a final draft can be issued. At that point we may want to officially transmit it to the applicant via an issue paper because of the time involved in publication.

Reference: [FAA SFAR Workshop, Seattle Washington, June 20-21.](#)

30. (9/24/2001) Are certain Convair models (580, 600, 640) designated by the change from recip to turboprop under STCs, which were issued after Jan. 1, 1958, affected by SFAR 88?

The SFAR 88 does not apply to the Convair 240, 340 and 440s as their type certificate was issued before Jan. 1, 1958. SFAR does not apply to the Convair models designated under STC (engine type change) as the applicability of SFAR 88 is specific to turbine powered aircraft whose TC was issued after January 1, 1958. Our intent was to make the delineator TC rather than STC.

31. (10/2/2001) If an applicant applies after 6/6/2001, what does the applicant need to do?

After June 6, 2001

Under Order 8110.4B, Section 2-10d, Changed Aviation Products, each ACO is to request the applicant to update the certification basis in the area of change, which would include adding the revised § 25.981 and Appendix H (H25.4) [Amdt. 25-102 effective June 6, 2001]. If the applicant does not sufficiently argue to the ACOs satisfaction that the revised § 25.981 and Appendix H (H25.4) do not apply, then the ACO will have to review the design in detail.

If the proposed change consists of a new design or a substantially complete redesign of a component, equipment installation, or system installation, that might increase the risk of ignition of fuel vapors or make fuel tank vapors more flammable, the provisions of § 21.101(b)(1) require incorporation of Amendment 25-102 in the certification basis. Note that in adopting SFAR 88 and Amendment 25-102, the FAA determined that earlier regulations incorporated by reference in type certificates for products applied for before June 6, 2001, do not provide adequate standards with respect to proposed changes that may affect the airplane fuel tank system.

If the proposed change is not a new design or not a complete redesign of a component, equipment installation, or system installation (such as rerouting of wiring and plumbing) but the change is perceived to increase the risk of producing a fuel tank ignition source or increase the risk of having flammable vapors in a fuel tank, that proposed change may be considered an unsafe design feature (§ 21.21(b)(2)) and should not be approved until the standards of Amendment 25-102 are met.

When the changed product rule (CPR) becomes effective, which is currently scheduled to be June 10, 2003, use the revised § 21.101 and the guidance associated with Amendments 21-77 in determining the application of Amendment 25-102. (Reference: Amendment 21-77, FR Vol. 65, Notice 1100, page 36244 and Amendment 21-77B, FR Vol. 66, Number 220, page 56989). The FAA will evaluate the need for additional guidance with respect to the means of applying Amendment 25-102 as the effective date of the change product rule approaches.

32. What if the applicant has moved but the data has not?

The two affected ACOs should work together to work out the transfer of data to the geographic ACO.

33. (10/22/2001) SFAR 88 states "Conduct a safety review of the airplane...to determine that the design meets the requirements of § 25.901 and 25.981(a) and (b). But § 25.901b(ii) says that the power-plant installation must comply with the applicable provisions of this subpart (E). Does this mean that all-applicable paragraphs of subpart E should be addressed in the safety review?"

The consequences of failures (single and combinations) relative to fuel tank explosions was what was intended to be re-evaluated by the safety review. We did not intend to revalidate the fuel system to all possible aspects of § 25.901.

34. (10/24/2001) A holder has a STC that SFAR 88 applies, but hasn't sold any STC installations. Is there a way they can put off compliance pending a sale?

For existing STCs that have not been installed, the STC holder can petition for exemption, which would include a limitation that SFAR 88 be complied with prior to STC installation.

35. (11/6/2001) In Part 21, SFAR-88 Number 2(c) {Federal Register: page 23129, Volume 66, No. 88, Monday, May 7, 2001} it states "Submit a report for approval ..." What is the intent as to the contents of this report? Also, what constitutes "... substantiation..." required in (c)(1)? The answer to these will assist us in forecasting the level of future workload we might expect at the NYACO.

2(c) reads:

Submit a report for approval to the FAA Aircraft Certification Office (ACO), or office of the Transport Airplane Directorate, having cognizance over the type certificate for the affected airplane, that:

- (1) Provides substantiation that the airplane fuel tank system design, including all necessary design changes, meets the requirements of Secs. 25.901 and 25.981(a) and (b) of this chapter; and
- (2) Contains all maintenance and inspection instructions necessary to maintain the design features required to preclude the existence or development of an ignition source within the fuel tank system throughout the operational life of the airplane.

The intent of the report mentioned in (c) is to provide substantiation of compliance with (c)(1) like substantiation of compliance with any other rule, and the report would also contain maintenance and inspections (instructions for continued airworthiness) necessary to maintain the design features.

36. (12/03/2001) Latent Failure Conditions. What is the FAA interpretation of the wording in the rule "demonstrating that an ignition source could not result from each single failure in combination with each latent failure condition not shown to be extremely remote..."? This appears to be contradicted by AC 25.981-1B Para. 9(c)(4) "...requires that any anticipated failure condition not leave the airplane one failure away from a catastrophic fuel tank ignition...", and clarification is requested.

The two statements are intended to require consideration of latent failures. This requirement is sometimes referred to as "specific risk". The wording in the AC is guidance; therefore, the wording of the rule takes precedence over the wording in the AC.

37. (12/03/2001) Filament Heating Energy Limit. AC 25.981-1B states "electrical power with the potential to create a filament heating ignition source in the fuel tank should be limited to less than 30 milliamperes RMS." The AC discusses "analyses and testing" that show this current is sufficient to ignite jet fuel, however, a TC holder has requested more specific information regarding the origin of this 30-mA limit value.

The value in the AC is being revised based upon comments from the Workshop. Testing was conducted using steel wool. See question/answer number 6b.

38. (12/03/2001) 3. Electrical Arcs. AC 25.981-1B states "electrical transients with the potential to create sparks in the fuel tank should be limited to less than 200 microjoules...a factor of safety should be applied to this value...For example, a maximum of 20 microjoules is considered intrinsically safe." A TC holder stated their belief that 320 microjoules, as specified in certain other standards, is a safe level. The TC holder has an action from our 23 Oct meeting to provide substantiation for the safety of the 320 microjoule level, however, any guidance or interpretation the FAA can provide on this issue (i.e. origin of the 200 microjoule value, SF of 10) would be appreciated.

The 200-microjoule value is based upon test data from Bureau of Mines testing and the FAA has used it for years. The safety factor of 10 is based upon the needed to provide margin from the design value to the "never exceed during failure conditions and maintenance intervals" value. See question/answer number 6a.

39. (12/03/2001) 4. Bonding. Figure 1 of AC 25.981-1B states that one of the Fuel Tank Ignition Source considerations is bonding, specifically, "Redundant Bond Paths". This was discussed at some length in the 23 Oct meeting, as apparently at the FAA SFAR workshop it was not clear what failures needed to be assumed (i.e. assume one bonding path is missing due to maintenance, does this mean three are required in the design?). Clarification is requested as to what the FAA would consider to be acceptable "redundant bond paths" for the SFAR.

As Jim Treacy stated this at the workshop a minimum, dual bond paths are likely required to meet the latent failure criteria. Even with dual paths, constraints on maintenance actions are likely required to prevent maintenance errors, such as making checks of bonds a required inspection item. (see AC discussion and workshop info on required inspection items). The other option is triple redundant paths. See question/answer numbers 4 and 25.

40. (12/05/2001) If I interpret the SFAR correctly, an applicant in before 6/6 has to comply with SFAR-88 by analyzing their product but only to the requirements of 25.981 a & b (pre amendment 25-102). If the applicant has to make modifications based on this analysis (amend the TC or STC), the modifications (as well as the basic design?) would then have to comply with the (post amendment 25-102) requirements of 25.981 a, b & c. Is this a correct presumption?

Design changes required as a result of SFAR 88 safety reviews need only comply with the SFAR criteria - §25.981 (a) & (b). However, if the design change adversely affects the "flammability characteristics" of the fuel tank(s), then I believe subparagraph §25.981(c) would also come into play. See Question 31.

41. (12/12/2001) Where do we stand in regard to having DERs approve compliance with SFAR-88?

DERs should recommend approval and the FAA will approve or disapprove.

42. (12/12/2001) Are Wiggins self-bonding couplings considered dual bond paths with regard to SFAR?

Single bond paths will not meet the fail-safe requirements of the SFAR. Inspections alone of wiring on a system where a single failure will cause an ignition source in the tank will not be acceptable. See question/answer 4 and 25.

43. (12/12/2001) What data do we have to support the 200-milijoule energy and 5 milliamp current levels?

See question/answers 6 and 38.

44. (12/13/2001) What is the FAA position regarding inclusion of SFAR 88 in the certification basis?

Add an item in the certification bases, "See note X" and then in the notes section add a note that compliance with SFAR 88 has been found in Document YYY (or similar wording of compliance). For project initiated after June 6, 2001, SFAR No. 88 does not apply.

45. (12/17/2001) Should SAE, Aerospace Recommended Practice, ARP 4761, issued 1996-12, "Guidelines and methods for conducting the safety assessment process on civil airborne systems and equipment" be used in showing compliance with SFAR 88?

If the risk being assessed is that associated with random multiple failures, then utilizing the standard practices of ARP 4761 can be appropriate. However, if the risk being assessed is that associated with an obscure single failure, then the most effective analytical tools may also include Weibull Analysis, Root Cause Analysis, Directed FMEA's, etc. Other analytical tools such as Markov or Monte Carlo modeling may be more appropriate and effective.

46. (1/7/2002) What is the status of the FAA modifications to AC 25.981-1B.

We anticipate the revised AC will be put on the internet for comment by the end of March. See question/answer 6 and 29.

47. (1/22/2002) Concerning STC projects that may not be affected by SFAR 88, can we accept information from the applicant that indicates no effect without the TC holder's SSA document?

We can certainly accept applicant's data. Whether it satisfies the requirements of SFAR 88 will need to be evaluated.

48. (2/8/2002) Two operators questioned the applicability of field approvals, minor changes and airline engineering approvals. Can they be covered (assessed) after the first 18 month or during?

Compliance is required by June 7, 2004. Operators may begin their assessments at any time.

49. (2/6/2002) Do switches outside the fuel tank need to be intrinsically safe?

No. The electrical components outside the fuel tanks but in those areas considered flammable vapor leakage zones need to be designed to prevent ignition of flammable vapors.

50. (2/6/2002) What about STCs that have been surrendered? What about old STC not currently in production? Who is responsible?

See Question 25 for surrendered STCs. For old STCs that are not currently under production, the STC holder is still responsible for their part of SFAR 88.

51. (1/29/2002) 1. One operator installed STCs on some Boeing 707 aircraft that have since been sold to the U.S. Air Force. Some of these aircraft are no longer in service, but some still are. The

operator would like to know if they should treat the U.S. military like any other operator or are those aircraft exempt from the SFAR 88 process?

Response: Yes, treat the US military like any other operator, but not necessarily a US operator. The SFAR does not treat TCs or STCs related to military airplanes or foreign operators differently than TCs/STCs in any type of service. It is our understanding that the military normally requires compliance with the FAA's airworthiness requirements. However, an exemption to the SFAR may be granted IF all of the following conditions were met: (a) it could be demonstrated that the only STCs are installed are on US military airplanes, (b) the US military does not intend to comply with the operating regulations associated with the SFAR, and (c) the US military would not comply with ADs that may be issued as a result of the design review required by the SFAR. In addition, a note would need to be added to the STC stating no further STCs could be installed until compliance is demonstrated with SFAR 88.

52. (1/29/2002) 2. What about the same situation with foreign military operators of aircraft, which have XXX Airlines STC's installed?

Response: Same answer as for #1, except replace the "US military" with "foreign military operators."

53. (1/29/2002) 3. What about the same situation with former XXX Airlines aircraft now operated by private foreign operators?

Response: Same as above, inserting "foreign operators".

54. (2/20/2002) 1. To what extent must repairs be addressed?

Repairs are not required to be addressed at any time, except when the operator has knowledge that a repair may affect the system safety analysis of a critical fuel tank system item.

55. (2/20/2002) 2. When a repair is known to affect the fuel system, when would the respective assessment have to be completed?

The System Safety Analyses (SSA) should be completed early enough to allow the FAA time to review and approve the operator's maintenance and inspection instructions that must be incorporated in their inspection program by June 7, 2004.

56. (2/20/2002) 3. The rule states that major alterations need to be assessed; when would such assessments have to be completed?

Major alterations would have to be assessed before June 7, 2004. Only TCs and STCs have to be assessed by December 6, 2002. Notwithstanding this intent of the rule, however, operators are advised and encouraged to coordinate with their PMIs early and often on any and all issues that may affect the carriers maintenance program required to be implemented by June 7, 2004, under Section 121.370(b).

57. (2/20/2002) 4. Do minor alterations have to be assessed?

An assessment would be required only if the operator is aware that the alteration has an effect on the fuel system safety.

58. (2/20/2002) 5. In the case of STC holders (includes some operators), what provisions are made for SSA's that cannot be completed prior to the Original Equipment Manufacturer having completed SSA's on the original Type Certificate and the OEM fails to complete the SSAs adequately in advance of the December 6, 2002, deadline?

STC holders should complete the SSAs to the extent that they can without the OEM's SSA's, and then identify in the reports required by SFAR 88 Section 2.(c) that the OEM's subsequent SSA on the TC could possibly affect the ultimate compliant configuration and maintenance requirements of the STC.

59. (2/20/2002) 6. In the case of STC holders who ultimately decide not to perform SSA's on their designs, and either are out of business or abandon or surrender their STC's, what provisions are made for the operators of such STC's who desire to continue them in service?

Surrendered STCs: The FAA would ask the certificate holder to provide sufficient data to allow the operator to conduct an SSA. The STC holder may or may not provide any data to FAA or anyone else to support SSA's for the systems.

Abandoned STCs: After searching to find the certificate holder, if not found the FAA can release whatever data it has. Note that it is the obligation of the operator to ensure that his airplane's fuel system receives a system safety review. Methods that could be used include pursuing the STC holding company and persuading it to perform the SSA, having the data transferred to the operator so that the operator may perform the analysis, or have a third party perform the SSA. If the STC holder's data can not be obtained, the operator should coordinate with the responsible ACO as soon as such a problem is recognized.

60. (2/20/2002) 7. What compliance deadline must the operator observe when the STC holder fails to complete the required assessment by December 6, 2002?

If the STC holder does not complete the design review by the December 6, 2002, deadline, that certificate holder may be subjected to enforcement action. Nevertheless, it is then the responsibility of the operator of that aircraft to address the STC as part of the carrier's maintenance program required to be implemented by June 7, 2004, under either §§ 91.410(b), 121.370(b), 125.248(b), or 129.32(b).

61. (2/20/2002) 8. Will the installation of barrier devices (Transient Suppression Devices, Transient Suppression Units, Isolated Fuel Quantity Transmitters, Ground Fault Interruptors) constitute an Alternate Means of Compliance for SFAR 88?

It is conceivable that the installation of a barrier device, or transient suppression device, in most circumstances could effectively constitute a means of compliance for the wiring and equipment protected by the device, but this would be a question for the TC or STC holder to determine in coordination with the corresponding ACO following the SSA. Barrier devices will in all likelihood require continuing maintenance. Note that SFAR 88 does not provide a provision for an "Alternate Means of Compliance". If a certificate holder plans to propose an Alternate Means of Compliance, the FAA would consider amending SFAR 88 to provide that provision.

62. (2/20/2002) 8. Does the report filed by TC and STC holders on or before December 6, 2002, per SFAR 88 have to receive prior DER approval?

No. The SFAR requires that a report be submitted to the ACO, and the ACO will approve or disapprove it. However, the fact that a DER has reviewed the report or portions of it may be beneficial in reducing the amount of time required by the ACO for its review.

63. (2/20/2002) What is the "actual configuration" of the aircraft?

Generally, the configuration of the aircraft is the actual configuration as indicated by manufacturers delivery documents and other data that identify subsequent modification by STC's, field approvals and major alterations. To the extent that repairs or minor alterations are known to exist and have a negative effect on fuel system safety, that knowledge is part of the configuration.

64. (2/21/2002) Is a DER review or recommendation needed for the safety analysis submitted under SFAR 88?

The use of a DER is desirable, but not required. The downside to not using the DER system is the additional time required for FAA review.
